

**EFFECTS OF SURGICAL STERILIZATION UPON HOME RANGE  
AREA OF SUBURBAN WHITE-TAILED DEER (*Odocoileus virginianus*)  
POPULATION**

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## ABSTRACT

As white-tailed deer (*Odocoileus virginianus*) populations continue to increase in suburban environments, local governments are considering ways to manage herd abundance and associated conflicts. Sterilization is one possible non-lethal method for controlling herd density, but little is known about the effects of sterilization on the behavior of female deer in suburban areas. We compared home range areas for a sample of sterilized (treated) female deer with home range sizes of reproductively-active females (controls). Between January 2002 and March 2005, 61 deer were captured, radio-collared, and located weekly using radio-telemetry in the Village of Cayuga Heights, New York. Sixteen deer were surgically sterilized. Neither annual nor seasonal average home range areas were significantly different between the control and sterilized groups. In 2004, a subset of the study population (long-term resident deer present in both 2002 and 2004), did have significantly different annual average home range areas ( $F= 5.946$ ,  $df = 1$ ,  $P < 0.05$ ). Control (27.7 ha) and sterilized (14.0 ha) long-term residents may have exhibited different home range use because of the behavior of control female deer caring for fawns during summer. The high site fidelity and survivorship of collared female deer indicates that sterilization could potentially have long-term effects, and may cause a slow population decline over several years. Continued resource utilization by sterilized deer would reduce the amount of resources available to reproductively-active immigrant deer.

## INTRODUCTION

Female white-tailed deer (*Odocoileus virginianus*) have been extensively studied in rural and cultivated regions of the United States (Tierson et al. 1985, Lesage et al. 2000, Nelson & Meck 1984). Studies focusing on the home ranges of suburban deer are limited and have not taken into account the growing amount of suburban habitat in the United States. Increases in deer-human incidents make studying and understanding the habits of suburban white-tailed deer of paramount importance (Kilpatrick et al. 1996, Decker et al. 2004). Suburban communities often lack the desire to engage in conventional methods of deer hunting or culling (DeNicola et al. 2000). Lethal control of deer can be politically contentious. Local government officials may be uncertain how to proceed, and therefore suburban deer populations are often unmanaged.

The costs of high densities of white-tailed deer in suburban environments have escalated during the past two decades. Animal-car accidents were estimated to number nearly 1.5 million and cost at least \$1.1 billion annually (Hedlund et al. 2004). Property damage includes damage to ornamental plantings, broken windows and fences, as well as damage to gardens and lawns. The cost of such property damage exceeds \$250 million annually (Creacy 2006). Limiting the possibility of accidents and damage has been a priority for local governments and state wildlife agencies, though suburban habitats present unique logistical challenges.

Residential areas often contain high deer densities, tended lawns, and interspersed woodland habitats. The high herd densities, in particular, pose a problem for wildlife managers who seek to reduce suburban deer populations (Shanahan et al. 2001). Discharge ordinances often make firing a weapon illegal, and public sentiment is also highly charged on issues of culling white-tailed deer (Shanahan et al. 2001, Decker et al.

2004). The underlying problem of planting highly nutritious ornamental plants that supply food year-round has yet to be convincingly addressed. Trapping and relocating, hiring sharpshooters, and deer sterilization have all been attempted with mixed success depending upon the community (Turner et al. 1992).

Sterilization has been seen as a popular, non-lethal control measure for some time (DeNicola et al. 2000) and offers communities an alternative to killing deer, but at great expense. The costs associated with identifying, capturing, and potentially recapturing fertile deer are often prohibitive (Merrill et al. 2006). Communities must also wait several years to realize the actual population reduction as some form of mortality is needed to remove adult deer. Yet as a non-lethal means of population control, sterilization may be utilized in suburban environments where political or logistical concerns trump traditional wildlife management objectives (Merrill et al. 2006). Permits and support from the state wildlife agency are required to implement such a program.

Questions remain as to the overall effect sterilization has on deer populations at the community level (Whisenant 2003). The continued use of food and cover resources by sterilized deer may limit the resources available to reproductively-active deer that immigrate into the area. In suburban environments, resource utilization is an important aspect of population management, because suburban deer require a smaller area to satisfy their resource needs than rural deer populations (Grund et al. 2002). Grund et al. (2002) calculated summer home ranges of suburban deer of 50.4 ha compared with Tierson et al. (1985) who calculated summer home ranges of rural deer in the Adirondacks of 324.9 ha.

A deer's home range has traditionally been identified as the largest area within which a deer can meet its most basic needs (DeNicola et al. 2000, Kilpatrick et al. 2001).

Seasonal movements are therefore dictated by changes in habitat quality. Suburban deer do not experience dramatic changes in their habitats season to season, and Etter et al. (2002) found minimal home range shift between seasons. The reasons white-tailed deer become residents of a suburban area are associated with the behavior of their mother, the continuous source of highly nutritious food, plentiful shelter in small wooded areas, and the relative safety afforded by hunter-less suburban communities. Kilpatrick and Stober (2002) have shown how little a deer is willing to move its home range when presented with food at bait sites. Kilpatrick and Stober (2002) found deer always utilized a bait site if it fell within their home range, but home range size did not change.

Deer in suburban environments also benefit from social norms in suburban communities which penalize homeowners for having untended lawns and damaged ornamental plantings. In what can only be described as a fortuitous feedback cycle for a suburban deer, the damaged ornamental shrubs are often replanted anew, providing a fresh source of food. Fencing is expensive, and usually relatively few homeowners use physical barriers to protect plantings.

Though automobile accidents are a serious concern for wildlife managers, the number of white-tailed deer deaths from such accidents is not great enough to substantially impact a healthy deer population in suburban Chicago. Etter et al. (2002) found that automobile incidents were the primary cause of deer death, but drew the conclusion that high survival rates and philopatry allowed for high densities to be sustained in suburban habitats. The underlying site fidelity of Etter et al.'s research is supported by deer movement studies (Cornicelli et al. 1996). Survival rates greater than

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## STUDY AREA

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Cayuga Heights was chosen as a study site for the unique opportunity it provided to study a free-ranging white-tailed deer population within a heavily populated suburban environment. The Village of Cayuga Heights has experienced only minimal residential and commercial construction in the recent past. The habitat structure has therefore changed little and few new woodlands or open spaces have been created. Cayuga Heights has a mature road network with only a single 4-lane highway, NYS Route 13, passing through its western and northwestern boundaries. All other roads in Cayuga Heights are local roads with a speed limit of 48 km/h (30mph) (Boldgiv 2001). The herd size was estimated by Boldgiv (2001) to have peaked at 154 deer in the spring and fall of 2000. Later population estimates have estimated the deer population of Cayuga Heights to be 137 deer in spring 2005 and 147 deer in spring 2006 (C. Jennelle, Cornell University, unpublished data). Boldgiv (2001) and Jennelle (unpublished data) both note deer-automobile accidents as the primary cause of deer fatalities.

The western edge of Cayuga Heights was dominated by a wooded hillside. The southern edge is the most densely human populated section of the village with Cornell University's and the City of Ithaca's border. Cayuga Heights' eastern boundary is a continuation of the village's predominately suburban landscape while the northern boundary is highly developed and urbanized with three large commercial developments, large apartment complexes, and Route 13 dominating the landscape. The single most defining feature of Cayuga Heights is the Kendal property. Kendal is a 40.5 ha (100 acre), actively landscaped retirement community interspersed with single-story apartment buildings and ringed by fields and wooded marshland which serve as deer bedding habitat. The contiguous nature and sheer size of Kendal represents an important resting

area for Cayuga Height's deer, and supplies them with a ready refuge and easy access to residential areas.

## **METHODS**

### **Capture**

Deer were captured in two distinct intervals, during winter (January to March) 2000 and during each winter from 2002 through 2005. During 2002 to 2005, deer were captured primarily from November through April. Between January and March 2000 50 deer were captured (Boldgiv 2001). During March 2002 and March 2005, 73 deer were caught. Each captured deer was fitted with alpha-numeric collars and numeric ear tags. Deer caught between January and March 2000 were originally tagged as part of a population study independent of this experiment. Tagged deer from this earlier research persisted in Cayuga Heights, however, and many were subsequently recaptured, located, and usually sterilized upon recapture.

Clover traps (Clover 1956), rocket nets (Hawkins et al. 1968), and drop nets were used to capture deer. Drop nets consisted of large pyramidal rope nets staked to the ground and suspended off large tree branches. The nets were released from nearby blinds. Trapping sites were baited with apples nightly for approximately four days to acclimate deer to walking under suspended net.

Captured deer were given a 5-cc intramuscular injection of Ketamine hydrochloride:Xylazine hydrochloride 1:1 mix at the time of capture (Jacobsen 1983), and a 3-cc intravenous injection of Yohimbine after processing to reverse the effects of the Xylazine (Hsu and Shulaw 1984, Jessup and Jones 1983). Fawns received the same



mixture of anesthetics but required only 3-cc of the Ketamine hydrochloride:Xylazine hydrochloride mixture, and 1-cc of Yohimbine for drug reversal.

Once sedated, captured deer would be loaded in a truck and taken to the Cornell University College of Veterinary Medicine, where a team of veterinarians would perform the sterilization surgery (Animal Care Procedure #00-05, NYSDEC Special License Unit #LCP00-041). Two methods of surgical sterilization were included in this study: tubal ligation and ovariectomy. Tubal ligations were performed on pregnant females leaving the sexual organs of does complete, but for a missing connection between the ovaries and uterus. Ovariectomy procedures were used on non-pregnant females removing the ovaries of does, and therefore affected their hormonal levels. Upon completing the surgery the captured deer was returned to the community and released with unique tags.

### **Location Sampling**

Sixty-one radio collared deer were located a minimum of once a week by driving through the Village of Cayuga Heights and pinpointing telemetry locations on a tax parcel map obtained from the Tompkins County GIS Department. Deer frequencies were input into a digital radio receiver (Communications Specialists, Inc., Orange, CA) linked to a directional antenna. When a deer's signal was identified the deer was approached from as many possible angles as the road network would allow (Boldgiv 2001). Given the completeness of Cayuga Heights' road system, a deer was usually able to be located to within a single parcel. Radio telemetry most often occurred during daytime hours.

Upon completing a radio telemetry location session, the deer coordinates were digitized into the GIS program Manifold System (CDA International 2006). Within

Manifold System an exact digital copy of the field tax parcel map was replicated allowing the telemetry locations to be accurately digitized from the field data sheet. Additional data such as the behavior of the deer, the other tagged deer present, and the total size of the family group present upon sighting were added if applicable. Between January 2001 and March 2005, 3,525 deer locations were recorded for the 61 radio-collared deer (Figure 2).

An error-testing experiment was conducted to determine the average error for deer locations. Radio collars were hidden throughout the Village of Cayuga Heights and then located in the same manner as a collared deer. GPS locations of the hidden collars were then compared to the digitized locations of the hidden collars using a paired nearest neighbor analysis. Twelve radio collars were hidden for each of four replicates, for a total of 48 paired error distances.

Deer locations were also obtained through community reporting. Local citizens, upon seeing a deer, would often email or telephone in reports. Reports typically included which deer was seen, where that deer was seen, the time of the sighting and which other deer were present as well as the deer's behavior. Community reports were deemed reliable through a vetting process that discarded reports which were unreliable (e.g. ear tag and collar number did not match). Local citizens often became reliable and consistent reporters of deer activity. Community reports had the advantage of encompassing a wider range of daylight hours.

### **Home Range Calculations**

Home ranges were constructed using the Home Range Extension for ArcView (Rodgers & Carr 1998) within ArcView 3.2 (ESRI 1999). Based upon the findings of Worton (1989) home ranges were constructed using an adaptive kernel home range estimator. A least-squares cross-validation smoothing factor within the Home Range Extension for ArcView was used. Home ranges were constructed using the 95% probability volume contour (Figure 3). Home ranges were constructed seasonally only for does who had a minimum of 12 telemetry locations per season.

### **Land Cover Analysis**

A land cover analysis was conducted using nine land cover types within a 50m grid matrix (Figure 4). The land cover grid encompassed 1,265 hectares, the political boundary of Cayuga Heights as well as a buffer area outside the boundary which included all areas with deer home ranges. Grid cells were classified based upon a majority rule, which dictated that the dominate land cover type within each grid cell was assigned as the land cover type. Special circumstances were associated with small waterbodies, developed areas and median strips. Small waterbodies smaller than 2500 m<sup>2</sup> (one grid cell) were assigned the land cover type of the non-water land cover. Developed areas, in addition to the definition, also included other land cover types which were completely enclosed by the developed area (i.e., grassy areas within parking lots). Median strips, like the areas described above, were also categorized as developed because they were surrounded by highways.

### **Statistical Analyses**

Statistical analyses were utilized to compare the average home range areas of different treatment groups and population subsets. Histograms were utilized to determine the normalcy of the original data. Non-normal data was transformed using a log base 10 transformation (Fowler & Cohen 1990).

Annual average home range sizes were produced for the non-sterilized population of tagged female deer in 2002, as well as the non-sterilized and sterilized tagged female population in 2004. Two one-way ANOVA tests were utilized to compare means for the three groups of deer. Home range sizes for non-sterilized females in 2002 were compared to control females in 2004. Average home ranges for control females were compared to sterilized deer within 2004.

A population subset was extracted from the larger data set and included all deer who were present in both 2002 and 2004. Similar to the above annual mean comparisons, the population subset comparisons utilized a one-way ANOVA test to determine differences between deer which either remained non-sterilized from 2002 to 2004, or changed treatment groups from non-sterilized to sterilized from 2002 to 2004.

Upon finding a significant difference in either ANOVA comparisons, a Tukey's Honestly Significantly Different (HSD) test was utilized to identify which seasons within the year were responsible for the greatest differences (Grund et al. 2002).

## **RESULTS**

Sixty-one deer were actively located between January 2002 and March 2005. In that period 3,525 location estimates were recorded; 617 (17.5%) were citizen reports and 2,908 (82.5%) were telemetry locations. The mean telemetry location error was

approximately 48m based on 36 paired nearest-neighbor telemetry locations. The land cover grid matrix's grid size of 50m was based upon the mean telemetry location error.

The land cover of Cayuga Heights was heavily landscaped (26.3%) though collectively, wooded and forested land cover types account for 426.3 hectares or 36.5% of the total area of Cayuga Heights (Table 1). Developed land was the second most abundant land cover type, covering 186 hectares (14.7%) of Cayuga Heights (Figure 4).

One-hundred and fifteen seasonal home ranges were determined for 35 female deer and ranged from 0.8 hectares to 212.8 hectares, although 75% of home ranges were <36.9 hectares. The mean home range for all does in the study was 26.8 hectares. Mean yearly home ranges did not differ significantly between years or treatments. Home range areas were 5 hectares smaller for control female deer in 2002 than in 2004, and 3 hectares smaller for control female deer than sterilized deer in 2004 (Table 2).

Average annual home range sizes for the long-term residents were significantly different ( $F= 5.946$ ,  $df = 1$ ,  $P < 0.05$ ) between control females and sterilized does in 2004 (Table 2). The difference in mean home range area between these subpopulations was 3.7 hectares.

Average seasonal home range areas for control females were not significantly different between 2002 and 2004. Comparisons between control and sterilized population groups were also not significantly different. Summer home range areas for control deer in both 2002 and 2004 was an average of 45% smaller than during other seasons (Table 3). Sterilized deer did not exhibit such a dramatic change in summer home range size (Figure 5).

Post hoc Tukey HSD tests showed that no individual season was significantly different for long-term resident deer. The fall 2004 season was the closest to being significantly different, with the lower limit of its 95% confidence interval nearing zero.

## DISCUSSION

The high level of philopatry in the deer of Cayuga Heights reflects the abundance of highly nutritious food and low death rates. Between 2002 and 2004 control females exhibited no significant changes in their mean annual home range area. Given the resource availability within Cayuga Heights, the fidelity of non-sterilized deer to their home ranges is rational and foreseeable. Even during the summer months, when non-sterilized deer would be caring for fawns and using more open habitats (e.g. goldenrod fields), the mean home range area did not differ significantly from other seasons (Table 3).

Though not significantly different from other seasons, the mean summer home range area for control female deer was smaller than in other seasons in both 2002 and 2004. This smaller home range area may represent the actual change in behavior of a doe caring for a newborn fawns. Pregnant and nursing female deer have been found to have smaller home ranges than barren females (Aycrigg & Porter 1997). Orzoga et al. (1982) observed that female deer establish smaller home ranges and remain territorial of their home ranges for up to two months after giving birth. Female deer who did not give birth neither shrunk their home ranges nor became territorial. These observations by Orzoga et al. (1982) may be important clues to why the seasonal summer home ranges are smaller

for control deer. However, the change in mean home range area was not significant and may reflect the high density of nutritious food sources.

The average annual home range area for sterilized deer was not significantly different from the home range areas for control deer in 2004. Significant shifts in average annual home range area were identified only for a subset of the study population, long-term residents, that were captured and radio-collared in 2002, and then later recaptured and sterilized in 2004 (Table 2). Given the continuity of these females throughout the study, the significant change in home range area has important management implications. The areas used by long-term resident sterilized females in 2004 were significantly smaller than for long-term resident control females. Though seasonal data for the total study population indicated a decrease in home range area during summer for control deer, this was not as well-defined in the long-term resident population.

Cayuga Heights' female deer used relatively consistent, small home ranges due to the plentiful shelter, high density of food resources, and high survival rates. Small wooded areas that separate individual residences, and larger wooded areas interspersed throughout the community, provided shelter for collared deer. Forest-like habitats (Wooded, Heavily Wood Deciduous, and Heavily Wooded Coniferous) represent approximately 37% of the land area of Cayuga Heights. These areas range from hedgerows between homes, to large woodlots with less human activity. Large contiguous forest plots are present on both the western and northeastern edges of Cayuga Heights. The spatial location of wood lots was very important because it offered deer safe bedding grounds near food resources without having to travel across main roads, commercial developments, or other potential hazards.

Food resources primarily consisted of ornamental plantings surrounding residences and businesses, and young saplings along the edges of mowed fields and power line corridors. The food resources were plentiful year-round, and were dispersed across all areas of Cayuga Heights. Cayuga Heights has experienced minimal development in the past four years, and landscaped residential yards have matured and were constantly maintained for aesthetics. Cayuga Heights was also interspersed with forested land which interfaces with old fields, landscaped properties, and power line corridors to create a suitable edge habitat where young saplings and shrubs thrive. Edge habitat is an important source of food, and the close proximity of bedding grounds to food resources also limited the amount of effort required to find enough food (Cadenasso & Pickett 2000).

The high survival rate of Cayuga Heights' female deer further contributes to the constant and well-established home range areas (C. Jennelle, Cornell University, unpublished data). Though automobile-deer accidents were identified by Boldgiv (2001) as the leading cause of fatalities for Cayuga Heights' deer, the total number of deaths was not great enough to impact the overall resident deer population. Additional research in 2006 estimated that the survival rates of Cayuga Heights' adult females deer population was approximately 94% (C. Jennelle, Cornell University, unpublished data).

The entire study area, within the town- or city-sized scale, represents a refuge from hunters. The Village of Cayuga Heights has a no-discharge ordinance that outlaws all possible methods of hunting. The community of South Lansing, directly to the north of Cayuga Heights, also has a very high density of deer and prohibits hunting. Immigrant deer from Lansing may enter Cayuga Heights.



Significant amounts of research have focused on the annual and seasonal home range shifts of rural and agricultural deer populations (Inglis et al. 1979, Vercauteren & Hygnstrom 1998, Lesage et al. 2000). Lesage et al. (2000) observed that deer living in rural areas exhibited home ranges up to 80 times larger than the females in this study. High philopatry has also been noted in rural and agricultural deer populations. This may explain why immigration from neighboring areas probably does not play a significant role in explaining habitat utilization or home range size.

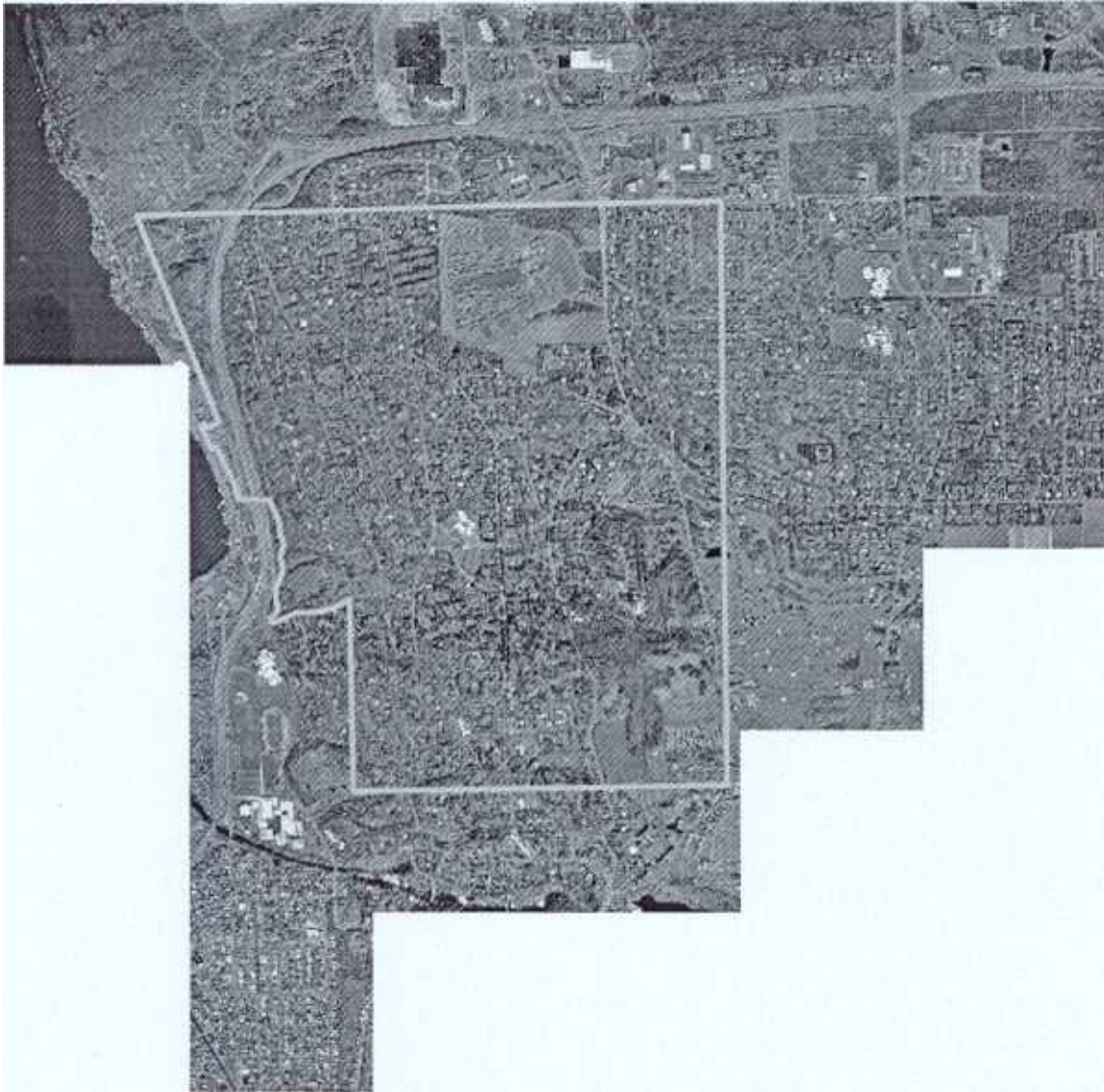
A move towards a deer population control program that first sterilizes an acceptable number of deer, and then culls non-sterilized animals, would be worth evaluating in a suburban community. Such a program would benefit from the high site fidelity and restricted home ranges deer exhibited in suburban environments. After both sterilizing and culling female deer, a community would experience both decreased population size and potential for future growth because only reproductively active immigrants would be raising fawns. Immigration into the community would probably be low, given that I observed consistently small and stable home ranges over time. Immigration would be especially low in suburban communities surrounded by other suburban-like habitats.

Sampling strategies may have contributed to the finding of no significant shifts in home range area between years in this experiment. Telemetry locations were primarily obtained during normal working hours between 9 am and 5 pm. Deer are most active during the early morning and evening hours. Deer were primarily located at times when they were inactive, bedded down, or simply conservative in their movements. Consequentially, home range sizes reported should be considered as minimum values.

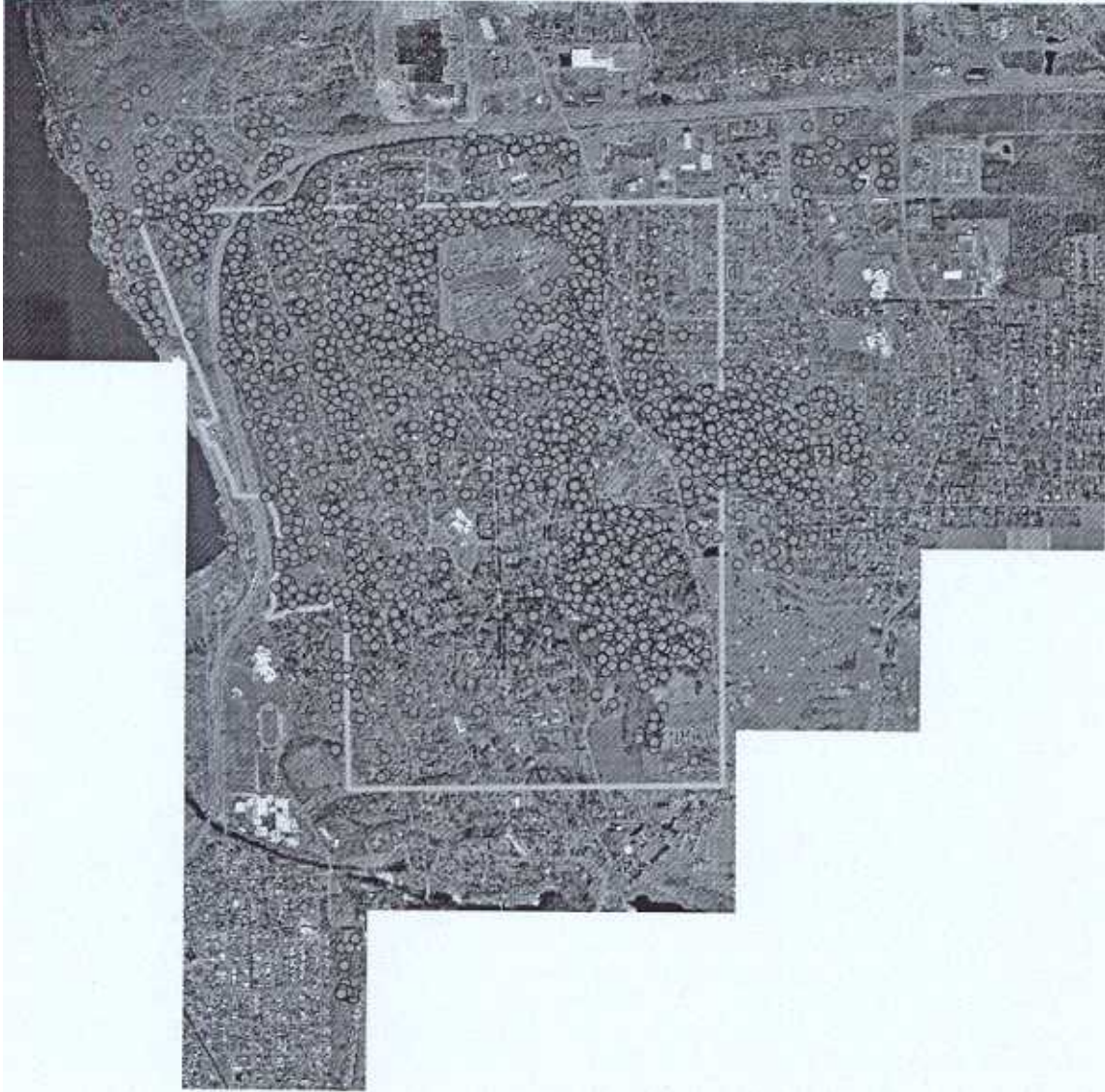
Culling, or trapping and relocating deer, would cause an immediate decrease in the number of deer within a community. A sterilization program would leave non-reproductively active deer in the community, and population reductions would result primarily from vehicle accidents. The cost of the two options, an immediate decrease in population or longer-term population decline, depends upon the objectives of the reduction program and the community's willingness to accept the costs of deer in and around their residences and roads. This research supports a finding that sterilized females remain in a community within their established home ranges, and thus continue to utilize food and shelter resources. The change in a community's deer population after a sterilization program will therefore be static during the short-term (less than 3 years), but potentially decrease over the long-term. A culling program would lower a deer population rapidly, but may also open food and shelter resources to immigrant deer.

## **CONCLUSIONS**

White-tailed deer will continue to be problematic in suburban environments as long as food and shelter remain plentiful. Coupled with high deer survival rates, communities must begin seeking effective and acceptable methods of population control to meet their management objectives. Sterilized female deer remained within the community and continued to compete for resources. This may buffer the community against population increases by limiting the amount of space available for immigration of reproductively active deer into the community. However, citizens must be willing to accept the cost of sterilizing deer, and continue to experience negative (vehicle accidents, plant damage etc.) associated with high deer densities.



**Figure 1.** Outline of Village of Cayuga Heights. The Town of Lansing sits to the north of Cayuga Heights and the Town of Ithaca lies to the west and south.

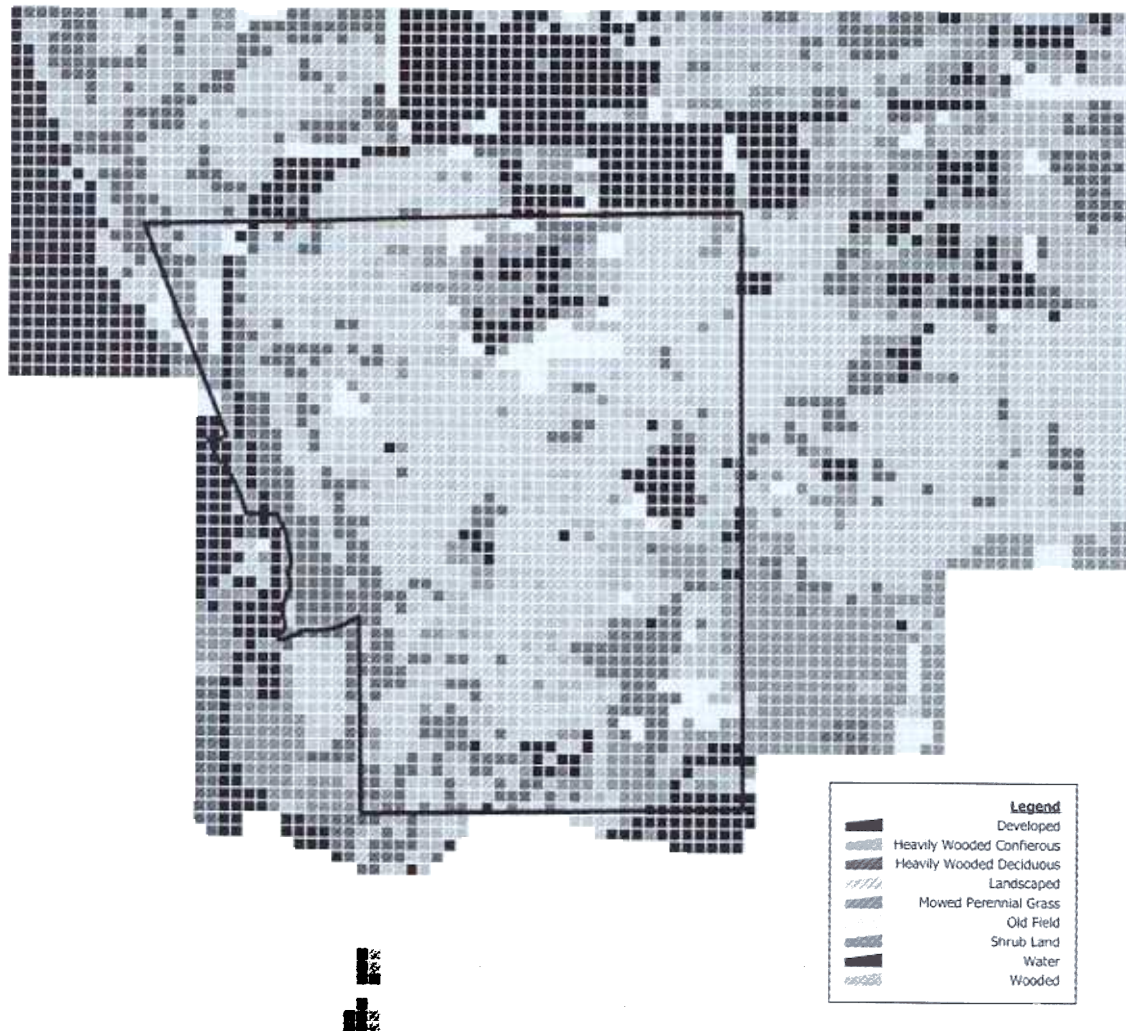


**Figure 2.** Location samples of 61 radio-collared deer between January 2002 and March 2005. Of the 3525 points collected, 17.5% were citizen reports and 82.5% were telemetry points.

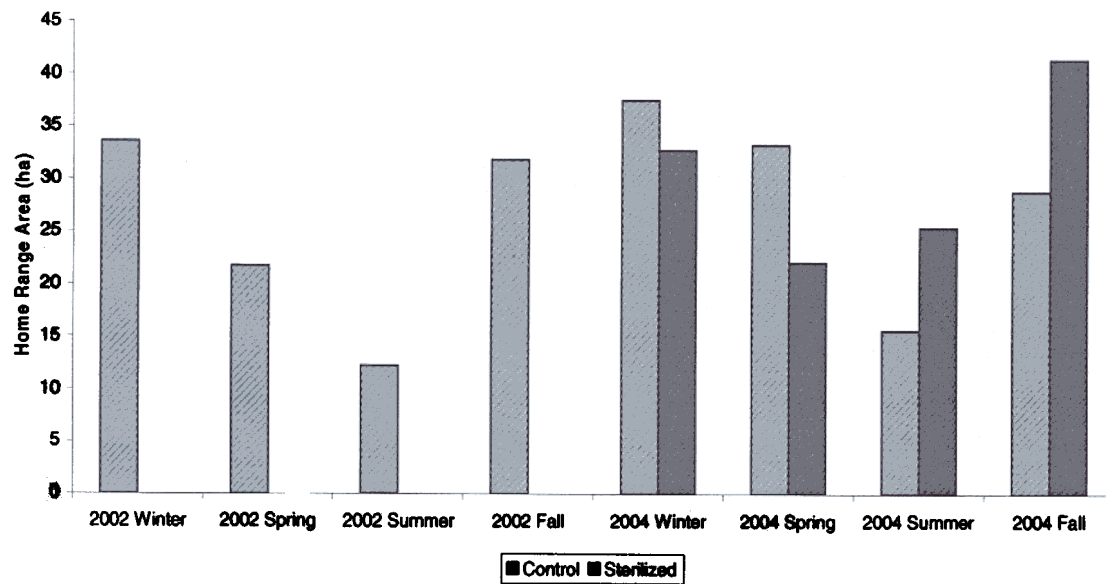




**Figure 3.** Example of 95% home range contours created for two does during the summer of 2004. The blue volume represents home range for Deer 73, a sterilized doe, and is 20.25 hectares large. The red volume represents home of Deer 66, a non-sterilized doe, and is 10.36 hectares large.



**Figure 4.** Land cover grid matrix for the Village of Cayuga Heights and the surrounding area. Nine land cover categories were used to populate the 50m grid cells (Table 1). The landscaped land cover type accounted for the most area, 332.5 hectares, followed by developed land, 186 hectares and heavily wooded deciduous land, 183.5 hectares. Wooded and forested land cover types together accounted for 37% of the total area of Cayuga Heights.



**Figure 5.** Average annual home ranges for control and sterilized treatment groups. Summer home ranges for control female deer were smaller than other seasons but not significantly different.

**Table 1.** Description of nine land cover categories used to populate land cover grid matrix of the Village of Cayuga Heights, New York.

Land Cover Classifications	Land Cover Area (ha)	Percent Land Cover	Description
Developed	186.0	14.7	Buildings, parking lots and highways. Median strips and areas wholly surrounded by other developed areas are classified as developed.
Heavily Wooded Coniferous	138.3	10.9	Dense coniferous forest area with ground cover of shrubs and near complete coniferous canopy.
Heavily Wooded Deciduous	183.5	14.5	Dense deciduous forest area with ground cover of shrubs and near complete deciduous canopy.
Landscaped	332.5	26.3	Yard-like area surrounding residences with gardens, planted ornamental shrubs and managed trees and bushes.
Mowed Perennial Grass	169.8	13.4	Low-cut grassy areas maintained for minimal growth (i.e. Golf Courses).
Old Field	46.3	3.7	Unmanaged grassy area.
Shrub Land	17.5	1.4	Unmanaged area with shrubs and young trees.
Water	51.0	4.0	Bodies of water larger than .25 hectares.
Wooded	140.5	11.1	Sparsely forested area with trees present but little or no ground cover other than grasses.



**Table 2.** Mean annual home range areas for control and sterilized female deer, Cayuga Heights, New York, 2002 to 2004.

	Year	n	Treatment Group		n	Mean Home Range Area (ha)
			Control	Sterilized		
			Mean Home Range Area (ha)	Mean Home Range Area (ha)		
Total Population	2002	18	22.8			
	2004	11	27.5		16	30.0
Long-Term Residents	2002	10	14.1			
	2004	6	27.7 <sup>a</sup>		4	14.0 <sup>a</sup>

<sup>a</sup> Significant difference was found between the long-term resident treatment groups in 2004 ( $F= 5.946$ ,  $df = 1$ ,  $P < 0.05$ ).

**Table 3.** Seasonal mean home range areas control and sterilized female deer, Cayuga Heights, New York, 2002 to 2004. Control and sterilized deer did not significantly differ in their seasonal home range areas.

		Mean Home Range Area (ha)			<u>Fall</u>
		<u>Winter</u>	<u>Spring</u>	<u>Summer</u>	
2002	Control	33.5	21.7	12.1	
	n	6	5	14	
2004	Control	37.3	33.1	15.6	
	n	5	7	8	
	Sterilized	32.6	22.0	25.2	
	n	13	13	13	

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